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POTASSIUM PERSPECTIVES: A BOTANICAL EXPLORATION OF TOMATO (*Solanum lycopersicum* L.VAR. AP3) PLANT GROWTH

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Abstract:

A study examining the effects of potassium fertilization on tomato plants was conducted. The research focused on potassium uptake, water efficiency, utilization, and overall plant morphology under different conditions. Potassium is an essential macronutrient for optimal growth and development in plants, including tomatoes. The study used controlled laboratory experiments to assess the relationship between potassium supply levels and tomato plant morphology and biomass accumulation three months after transplanting. The results showed a significant quadratic correlation between potassium supply and plant height and biomass accumulation, with the optimal potassium supply identified as 2ppm to 100ppm. The study also examined the effects of potassium on other aspects of tomato physiology, such as fruit yield, quality, and nutrient content. The research aimed to provide practical recommendations for enhancing tomato yield and quality while minimizing environmental impact and resource usage. The findings contribute to existing knowledge on plant nutrition and agricultural sustainability by offering empirical evidence and mechanistic insights into potassium's role in shaping tomato plant growth and development. The study evaluates the overall sustainability of potassium fertilization practices in tomato cultivation and agricultural systems worldwide.

Key Words: Potassium fertilization, Tomato plants, Morphology, Biomass accumulation, Nutrient content, Agricultural sustainability

Introduction:

Tomatoes are a vital vegetable crop globally, known for their nutritional richness and culinary versatility. The cultivation of high-quality tomatoes is crucial for farmers and researchers worldwide. Potassium (K), an essential macronutrient, plays a key role in the relationship between plant nutrition and agricultural productivity. Potassium regulates various physiological processes, such as enzyme activation, osmotic regulation, stomatal function, and protein synthesis, shaping plant morphology, biomass accumulation, and overall productivity. It also influences fruit quality attributes such as size, color, texture, taste, and nutritional composition, directly impacting consumer preferences and market value.

In this study, Potassium Hydroxide (KOH) was used as the main source of potassium for plants. Different levels of potassium concentration were applied at different time periods for the study. The role of potassium in increasing flower number, peduncle length, fruit set, and fruit number was examined, as potassium is crucial for balancing physiological activities (Besford and Maw, 1987). Potassium also has an important role on balancing physiological activities. It is not a constituent of organic structures, but regulates enzymatic activities (Over 60 enzymes require K for activation), translocation of photosynthates and considerably improves yield and post-harvest quality of fruits and vegetables (Mengel and Kirkby, 1987). Several authors have emphasized potassium's importance in enhancing post-harvest quality traits in tomato fruits and almost all vegetables. Potassium is more mobile in plants than calcium, phosphorus, and other elements and due to continuous cropping, soils seem inadequate in potassium (Erel, R., Yermiyahu and U., Ben-Gal, 2015). This inadequacy leads to decreased resistance to insect pests, diseases, and other hazards. Potassium deficiency can cause plant dwarfing, leaf chlorosis, decreases in leaf area and net photosynthetic rate, and ultimately inhibit plant growth and yield. There are still gaps in understanding potassium's ideal administration techniques, especially under states of restricted water accessibility. Investigating the collaboration between potassium treatment, shortfall water system systems, and their combined impacts on tomato development, quality, and resource usage is a fundamental area for research and practical application. This study aims to address these information gaps by analysing the effect of potassium preparation on tomato quality, plant potassium take-up, water proficiency, and potassium usage productivity under shortfall water system conditions.

Study Site: The study was conducted in the Botany lab of Maharishi University of Information Technology, Lucknow, Uttar Pradesh within a controlled laboratory environment.

Material and Method:

1. Experimental Setup: The experiment took place in a controlled laboratory setting with soil samples from a nearby garden. The tomato seeds, chosen from the T0-3251 variety, were chosen due to their widespread use in agricultural studies and well-documented growth characteristics.

2. Plant Material: The experiment utilised tomato seeds (*Solanum lycopersicum*) of variety T0-3251 due to their widespread use in agricultural studies and well-documented growth patterns.

3. Preparation of Potassium Hydroxide Solution: The experiment used Potassium Hydroxide (KOH) solution due to its high solubility and availability of potassium ions to plants. KOH pellets were weighed, dissolved in distilled water, and stirred until completely dissolved. The solution was then transferred to a volumetric flask and distilled water was added to achieve desired concentrations of 2ppm, 10ppm, 20ppm, 50ppm, and 100ppm. The process ensures the optimal concentration of potassium for plants.

4. Germination Process: Tomato seeds were soaked in water for 24 hours before planting to soften the seed coat and promote germination. After soaking, seeds were planted in pots filled with soil, sown at 1-2 centimetres deep, in a well-lit area, with temperature controlled to maintain optimal conditions. Soil moisture was monitored to ensure consistent moisture without waterlogging.

5. Planting: Two healthy seedlings were kept in each pot after germination, ensuring consistent growth conditions across six pots, with one pot serving as the control and the remaining pots labelled as experimental groups.

6. Potassium Treatment: The experiment involved plants being treated with potassium using KOH solutions, with the control group receiving regular watering, and the experimental groups receiving the desired concentrations, applied 25 and 40 days after germination.

7. Observation Parameters: Weekly observations were conducted to monitor growth parameters of plants, including plant height, leaf count, flowering, fruit weight, fresh and dry weight of root stem and leaves, and drying of samples in an oven. These observations were recorded using a ruler, manual counting, and weighing machines.

8. Harvesting: Harvesting occurred when fruits reached maturity, detaching from plants and inspecting for ripeness, colour, and overall quality before being harvested.

Results:

1. Impact of Potassium on Plant Height: After being treated with various potassium hydroxide concentrations, the tomato plants in this study displayed a range of heights. The group under control measured 32.2 cm, but the groups treated with 2 ppm, 10 ppm, 20 ppm, 50 ppm, and 100 ppm displayed increased and decreased growth, measuring 35.3 cm, 33.1 cm, 33.8 cm, and 33.6 cm, in that order.

2. **Impact of Potassium on Plant Morphology:** Five branches and a normal morphology were displayed by tomato plants in a study. Treatments with varying potassium hydroxide concentrations displayed various branching patterns. The plants treated with 2ppm, 10ppm, 20ppm, 50ppm, and 100ppm grew similarly to the control group, which had 5 branches. Despite slower growth, the 100 ppm treatment produced 7 branches.

3. Impact of Potassium on Reproductive Parts: The study found that plants treated with different concentrations of potassium hydroxide produced different flower numbers. Control plants produced 5 flowers, while those treated with 2ppm of potassium hydroxide produced 4 flowers. The highest flower production was observed in plants treated with 10ppm of potassium hydroxide, followed by 20ppm, 50ppm, and 100ppm.

4. Impact of Potassium on Total Fresh and Dry Weight: The study examined the impact of different concentrations of potassium hydroxide on plant growth. The control group maintained steady growth, while higher concentrations led to slightly reduced weights. The 10ppm concentration resulted in enhanced growth with higher fresh weights but lower dry weights. The 20ppm concentration maintained consistent growth with decreasing fresh weights and increasing dry weights. The 50ppm concentration showed satisfactory growth with slightly decreased fresh weights, while dry weights remained stable. The 100ppm concentration led to diminished growth, with higher fresh weights but lower dry weights. The study suggests lower concentrations support optimal growth.

S.No.	Treatment	Height (cm)					
		15th day	30th day	45th day	60th day	75th day	Day of Harvesting
1.	Control	6.1	11.2	16.3	24.6	30.4	32.2
2.	2ppm	6.0	10.2	15.9	23.8	30.1	32.7
3.	10ppm	7.2	12.3	18.4	24.2	32.4	35.3
4.	20ppm	6.3	11.3	16.3	23.4	30.2	33.1
5.	50ppm	6.1	11.7	16.9	25.4	31.3	33.8
6.	100ppm	5.3	10.9	15.8	24.8	29.4	33.6

***Table1:** Plant Height at different time intervals.

S.No.	Treatment	Leaves		Stem		Root		Total	
		Fresh Weight (gm)	Dry Weight (gm)	Fresh Weight (gm)	Dry Weight (gm)	Fresh Weight (gm)	Dry Weight (gm)	Fresh Weight (gm)	Dry Weight (gm)
1.	Control	28.80	12.10	26.80	11.64	3.95	1.63	59.55	25.37
2.	2ppm	20.80	7.73	20.80	7.06	3.20	1.42	44.60	20.79
3.	10ppm	17.87	4.48	15.05	5.11	3.20	1.40	36.12	11.99
4.	20ppm	11.80	4.85	15.83	7.70	2.32	1.23	40.95	13.81
5.	50ppm	13.50	5.12	12.40	5.20	2.38	1.04	28.28	11.38
6.	100ppm	25.50	14.85	20.40	6.63	3.96	1.82	49.86	23.30

***Table2:** Fresh weight, Dry weight and Total fresh and dry weight of leaves stem and root (at the time of harvesting).

Discussion: This study explores the impact of potassium fertilization on tomato plant physiology and morphology, aiming to optimize cultivation practices for improved yield and quality.

1. Control: The study compared tomato plants in a control group to those treated with varying potassium concentrations. The control group showed steady growth and reproductive development without additional potassium supplementation, allowing for evaluation of the efficacy of potassium fertilization in enhancing tomato plant growth and yield.

2. 2ppm Potassium Treatment: The 2ppm potassium treatment did not significantly impact tomato plant growth compared to the control group, suggesting it may not have provided enough supplementation to cause significant changes. Further analysis of nutrient uptake dynamics and metabolic responses could help understand the plant's response to potassium availability.

3. 10ppm Potassium Treatment: The 10ppm potassium treatment significantly improved tomato plant growth and reproductive performance, suggesting moderate potassium supplementation can enhance nutrient uptake, physiological processes, and yield-related traits in tomato plants.

4. 20ppm Potassium Treatment: The 20ppm potassium treatment showed similar growth responses to the control group, suggesting a potential saturation point. However, higher concentrations may not necessarily increase reproductive performance, suggesting further research for optimal nutrient management.

5. 50ppm Potassium Treatment: Tomato plants treated with 50ppm potassium hydroxide showed significant growth improvements, indicating a dose-dependent response. However, a reduction in fresh weights suggests potential limitations in nutrient uptake or physiological processes. Further research could optimize potassium fertilization strategies for crop productivity and quality.

6. 100ppm Potassium Treatment: The study found that potassium supplementation at a high concentration (100ppm) can disrupt reproductive processes, leading to decreased fruit set and yield. This suggests that further investigation into the physiological and molecular mechanisms of potassium toxicity is needed to optimize nutrient management practices and ensure sustainable crop production.

a

b

Fig1. a) *Solanum lycopersicum* plants after ten days of germination; b) *Solanum lycopersicum* plants after

forty-five days of germination.

a b

c d

e

Fig-2 Plants (a, b, c, d, e) treated with solutions containing 2 ppm, 10 ppm, 20 ppm, 50 ppm, and 100 ppm of potassium hydroxide, and growth compared to control.

Fig-3 Control, 2ppm,10ppm, 20ppm, 50ppm, 100ppm (left to right) showing growth before harvesting.

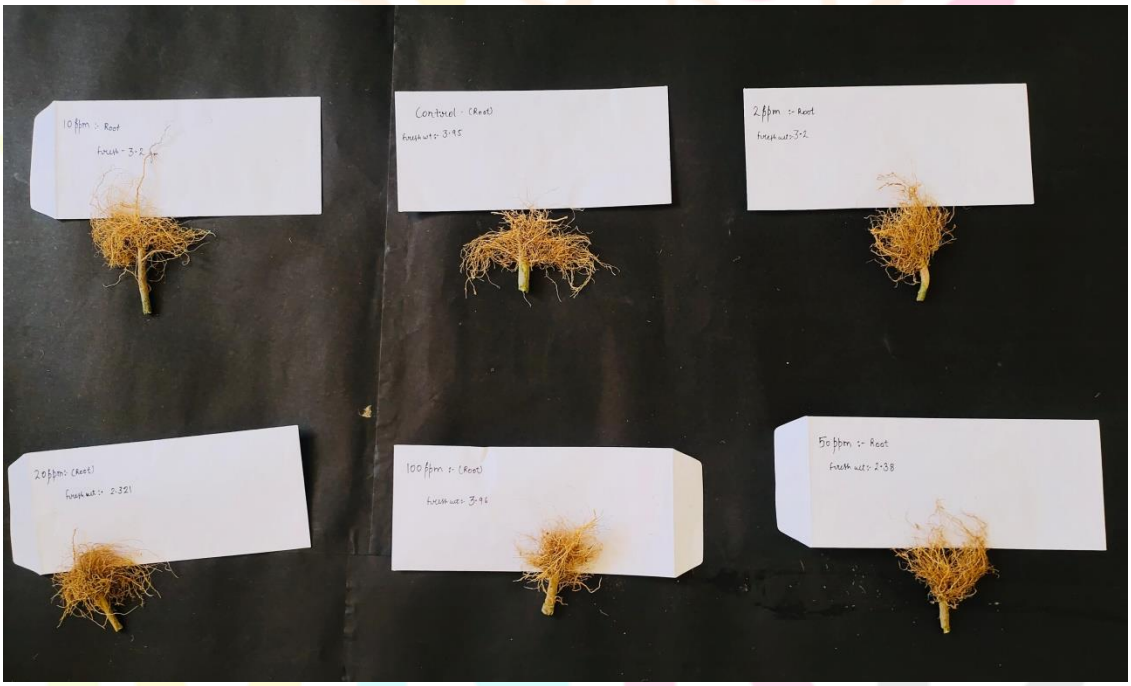

Fig-4 Postharvest condition of the root.

a b

Fig-5 Fruiting in KOH (potassium hydroxide) treatments at 20 ppm (a) and 50 ppm (b).

a

b

Fig-6 *Solanum lycopersicum* leaves were treated with KOH (potassium hydroxide) at concentrations of 50 ppm (a) and 100 ppm (b).

Conclusion: The study investigated the impact of potassium on tomato plant growth, focusing on height, morphology, reproductive components, and total biomass, conducted in a controlled laboratory setting at Maharishi University of Information Technology's Department of Botany in Lucknow, India. The research shed light on the pivotal role of potassium in shaping plant development, highlighting the need for optimal potassium levels to promote healthy growth. Moderate concentrations, particularly at 10ppm, result in taller

plants with increased lateral shoot development, indicating that potassium fosters cell elongation and branching, crucial for nutrient absorption and plant vigor. Potassium Hydroxide (KOH) is a water-soluble compound widely used in agriculture due to its high potassium content and ability to quickly provide potassium ions to plants. KOH is essential for various physiological processes, including photosynthesis, water regulation, enzyme activation, and osmotic balance. The study also found a positive correlation between potassium levels and reproductive output, with plants treated at 10ppm exhibiting the highest flower production. Excessive potassium concentrations led to diminishing returns, highlighting the need for balanced fertilization. Future research could explore alternative potassium sources, uptake mechanisms in tomato plants, and long-term effects of potassium fertilization on soil health and crop sustainability.

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